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NOTES ON CERTAIN BEES, WITH A CONSIDERATION OF THE USE OF THE ABDOMEN IN NEST CONSTRUCTION.

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Some wasps make important and prolonged use of the abdomen in the final closure of the tunnel in nesting. This is well illustrated by several species of the spider wasps belonging to the Pompilidae. The use consists of forceful blows or a rapid tapping of the soil with the end or body of the abdomen, resulting in a packing of the nesting material and subsequent greater safety and security to the young. Less well-known and conspicuous examples may sometimes be met with in other wasps.

Certain bees exercise this part of the body to advantage also, as shown by the resin worker, *Dianthidium pudicum* Cresson.* This bee employs its abdomen in the task of fitting pebbles in the resin of its cell and nest. While studying different wild bees in the field other uses have been observed, a few of which are mentioned in connection with some facts in regard to the activities of three species, found at or near Boulder, Colorado.

A pretty black bee, *Pseudopanurgus aethiops* Cresson, ** fairly common at Boulder, was one early found to make extended use of the abdomen in constructing a tunnel. Some of its nesting habits were observed, mainly at Base Line Lake but also at Owens Lake, between July 28 and August 18, 1926.

When first witnessed, a female was found and followed, as she flew low over the surface or from time to time entered holes in the earth. This first activity suggested that of a parasite but later study proved this possibility to be false. Her search about depressions, the frequent temporary inability to locate a nest already started and her entrance into tunnels other than her own, pointed to the former; the actual digging and provisioning of nests indicated the latter.

Between July 28 and August 6, ten different females were seen to start a nest. Later, more were found. One was seen to alight and to begin to excavate in the cleared area near the hill of an ant, *Pogonomyrmex occidentalis* Cresson. This soon abandoned, a number of other places were tried, usually where a natural cavity was found in the soil. In one instance, she dug four different times at the same spot, leaving and returning to it after a brief abandonment. Again, one had started nicely in what appeared to be an *Halictus* tunnel, when suddenly the *Halictus* returned. This bee was much smaller than *P. aethiops* but it succeeded easily in driving her away and out of range for further observation.

These bees seem to dig readily in various places, abandoning quickly those which do not prove suitable. They were found to nest solitarily and were

*Hicks, Charles H., 1926. Parasites and Habits of *Dianthidium pudicum* Cresson. Psyche. Vol. XXXLV, No. 6, pp. 193-198.

**This species and others of this account were kindly determined by Dr. T. D. A. Cockerell.

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not common enough in this territory to often be found close together.

In starting a nest the jaws loosen the soil, which aided by the legs, force it back out of the way. Later, when the tunnel is well started, the soil is carried up and much of it smoothed along the inner walls of the shaft. The use of the abdomen has been observed many times in this work. Forced back and up by the aid of the legs, the soil is pounded, by slight blows of the curved abdomen, into the sides of the tunnel. The action of the abdomen is fairly rapid and very efficient. This use of the soil from below results not only in smoother walls but also in loose material being deposited on the surface at the orifice.

When the tunnel is being constructed the female sometimes has no open exit for a time through the mound. If such a mound be watched the material of the center will be seen to move upward from time to time, suggesting the movement of the soil as a mole creeps along. The movement is caused by the bee bringing fresh soil and forcing it into the mass from below. Thus, she works for periods with much of the light shut out from her tunnel. This habit may aid in keeping dangerous intruders away or parasites from locating the nest. The cone-shaped mass of excavated soil at one nest measured 35 mm. high in the center and gradually sloped to the sides.

The diameter of the tunnel varies a little, measuring from 4 to a little more than 5 mm. The length of the tunnel likewise is not constant; the extremes noted from nests containing cells have been 73 and 200 mm. The shafts appear to have a tendency to run straight but often curve a little to one side or the other. Some species of bees dig the main tunnel nearly straight into the earth others make them very winding. This species approaches the method of the former more than that of the latter.

During provisioning the entrance to the tunnel is closed with loose soil for only a part of the time, there appearing to be no constancy in this regard. The closure may aid in keeping other insects away. While observing one nesting on August 6, a *Nomada* sp. was found to enter an open nest of *P. aethiops* and was caught upon leaving. It may have been a parasite of this bee but more evidence than this has been found from previous observation to be necessary to connect a parasite with its host.

This nest extended into a loose but not sandy soil to a depth of over 80 mm. Near the inner end, a little to one side of the tunnel, one cell was found. It contained a little dry pollen where the bee, still present, had just added to its content.

A pollen-laden female was found on August 8 to enter a nest at Base Line Lake. The nest was marked at the time and ten days later excavated. The tunnel was smooth inside and led to five earthen cells, each of which contained a larva. The exact relationship of the cells to the main tunnel and to one another could not be determined but they were found close together with from 5 to 10 mm. of soil between them. The larvae were each placed in a capsule, taken to the laboratory but all later died, the conditions at the time apparently being unfavorable.

Occasionally, promisingly appearing tunnels were dug out in my search for the cells of this bee. One such nest was excavated at Base Line Lake on August 18. It was evidenced by the cone-shaped mass of loose soil about it, no longer

fresh but indicating that the digging had taken place some time previously.

At the end of a tunnel measuring 200 mm. in length three cells were found, each near to the main shaft and all exceedingly smooth on the inside. The first one contained a young larva on the pollen mass; the second was provisioned and contained an egg; the third contained some pollen near which was found the female bee, *P. aethiops*. Attempt was made to rear this larva but it also died in the laboratory.

Another nest observed a week before was dug out but it was found deserted. Rainy weather had caused part of the tunnel and the entrance to become filled with soil and had probably driven away the nesting bee.

A nest of this species at Owens Lake was found to penetrate an upper crust of clay but after entering a sandy stratum beneath, ended suddenly. This desertion was not due, it would seem, to this layer of sand, for many other individuals were nesting in this area. The cause, in this instance as well as that of several others, could not be easily or accurately obtained.

The females are often found on sunflowers and the pollen, which is stored in the cells for the young, is placed dry in the bottom until after the first few collecting trips. Then later, before the egg is laid, it is moistened with honey. The male was not seen often and when found was usually feeding from the sunflowers.

A second species, *Anthophora neomexicana* Ckll., was seen to use its abdomen in a manner similar to that referred to by other students* of the Anthophorinae. A few observations were made and reported on the habits and relationships of this bee by Hicks (26)**. Some facts, additional to those reported from Boulder, were later secured at Owens Lake in 1927, during the latter part of May. The bees were nesting in the soil between the roots of an old stump which had been cut off about two feet below the surface and later discarded in an open field. At the time, the colony consisted of eight bees and nine nests.

The exact space in which the tunnels entered was less than a square foot in area, thus allowing accurate and easy observation of the activities of the colony, with fewer distracting elements as compared with nests in a bank. Seven of the openings in the mixed clay material had soil extensions to the outside. These curved downward after a short outward projection. The upper side of each had a wide irregular split running its length, a condition not due to drying, as was first suggested, but formed in a natural way by the bee.

The extension from an orifice was observed under construction. Complete, the exterior is rough and irregular; the interior smooth, regular and of nearly constant diameter. It is formed piece by piece from soil removed from the nest, moistened by water (and probably some secretion), carried and regurgitated by the bee and spread in place.

The moist soil is brought from within, in a rather loose lump. Worked together into a compact ball by the mandibles and fore legs, it is next moved

* See Rau, Phil. The Biology and Behavior of Mining Bees, *Anthophora abrupta* and *Entechnia taurea*. Psyche. Vol. XXXVI, No. 3, pp. 155-181. This paper, in addition to mentioning the turret formation, (especially p. 161) gives references to articles by some other students.

** Hicks, Chas. H., Nesting Habits and Parasites of Certain Bees of Boulder County, Colorado, Univ. Colo. Studies, 15: 217-252, 1926.

back toward the end of the abdomen with the hinder legs. The tip of the abdomen then works it into place at the free end of the extension as it suddenly becomes very wet. It is at this point that the even-pressured taps of the abdomen form the smooth inner surface of the wet clay.

Time notes were taken on the activities of the bees of the numbered nests of this colony on May 22. The bee of number 3 nest was most active at this time in increasing the length of the extension of her tunnel and a partial review of her work is given below. The field notes were taken to the second but the following is given only to the nearest minute.

The extension at this tunnel measured 14 mm. in length. The bee was observed from 9:06 A.M. to 12 N. She was very dark, having more red on her body than any other one of the colony, although other variations in color were quite noticeable. Nineteen return trips were made from the field at average interval of 9.12 minutes. Ten periods at the nest varied in duration from 2 to 14 minutes, with an average of 6.8; ten trips away from the nest to the field from 1 to 14 minutes, with an average of 5.

The bee was not collecting in the field nor provisioning the nest at the time. All evidence pointed to the fact that she was in the process of excavating during this entire period. The squeaking noise commonly heard accompanied such work was often produced; moist, loose soil fell from the tunnel on two occasions; and soil was added to the extensions ten different times. The trips afield were many times, if not all, for the purpose of obtaining water for her work, the soil at the stump being very dry.

At one time, while the bee was within the tunnel, much of the length of the extension was intentionally broken off in order to observe any effect it might have upon her. But when she returned almost immediately to add to it, she did so without hesitation and with no apparent notice of the change.

During three trips collecting pollen (and honey?), the bee of nest number 1 spent 14, 28, and 17 minutes each; the time spent within to deposit it being respectively 2, 4, and 2 minutes. After the third observed trip (not the third in regard to the total number for the cell) the bee began trips to the field but returned with no pollen. It was believed that at this time she started a cap for the cell.

Three more females were provisioning while three others were apparently uncertain as to a nest site and were flying in and out and about, to no evident purpose. From time to time one of the latter would break some soil away from a smooth area with its mandibles and thus give evidence of seeking a place to form a nest.

These bees were easy to observe and to study and were not afraid of my presence nor disturbed by my near proximity to the nest. Their loud buzzing while in flight gave little chance for one to miss a return or a departure. The favorable size, in addition to the above characteristics, makes this species good for a motion picture of its life's activities.

Still another bee to furnish a good example of the use of the abdomen in nesting was *Augochlora coloradensis* (Titus), a beautiful greenish species quite common at Boulder. Some of its habits were observed at Base Line Lake on July 30 and 31, 1926. Time notes were taken on its activities, a summary of

which is given in the following account, along with a description of the nest and its contents.

A pollen-laden bee was found entering a tunnel in the ground on the morning of July 30th. An extension of the sides of the tunnel had been built up to a height of 5 mm. The diameter of the main tunnel and that of the extension was 8 or 9 mm., the inner surface of which was very smooth and even, while the outer was rough and uneven. The bee, upon returning, came direct and darted into the entrance.

It was soon evident that two bees were carrying pollen to the same nest. Each bee was spending, on an average, 30 minutes in collecting and nearly 3 minutes after each trip to work in the nest.

A third bee was early observed which served as a guard, remaining near the orifice while the other bees were collecting. Sometimes its head was very near the opening with the antennae extending beyond the surface or again, it was farther down, its head and body blocking the tunnel. When a pollen-laden bee returned, or after one had deposited its pollen and was ready to leave for more, this bee moved down to let it pass, after which its former position was resumed.

In an attempt to learn how the tunnel and cone were formed, water was sprinkled over the nest to soften the soil, after the fashion of rain. This brought up a bee, which moved its head as though looking about. It then backed down and a thick, improvisioned plug was placed in addition, into and over the hole. For an hour no visible action was noted but at the end of this period a bee was found working through the mass of wet soil. It reconstructed the upper end of the tunnel at once and later built up the cone.

The moist earth, which had been broken from the top with the mandibles and had fallen below, was carried up from the depths of the tunnel by the fore legs of the bee. It backed up to the place where it was repairing the walls and moved soil upwards and into place with the legs. The tip of the curved abdomen was then used to force or press the soil into place. After working for a period, the bee would turn about and appear to inspect the work already done. She would next go down, bring up more earth and continue as before. The extension of the wall of the tunnel was formed in the same manner as the walls below surface and it would seem that this is the normal method of construction and repair. Two bees were taken after this work had been acccomplished and the nest again covered with a mud plug. It was then left for the night.

The following day the orifice and upper tunnel was found repaired again, with the extension of the tunnel complete as before. The nest was then dug out. A third bee was found and taken in the tunnel.

The tunnel went almost straight into the earth to a depth of 60 mm. At this point it divided, going at right angles to the main tunnel and forming a circle which enclosed 5 cells whose long axes were parallel with the surface of the earth. One upper cell contained a cherry colored cocoon, which was doubtless that of some parasite; two cells contained mature larvae which had eaten all the food; one cell contained a rather large larva and some uneaten pollen; and the fifth cell held a larva and considerable uneaten food. This last cell was 8 mm. long and 4 mm. wide. The pollen was very moist as though mixed with honey.

All these cells were grouped together, with only thin partitions or layers of soil between them.

Three other cells were found below the five, each containing a mass of pollen about 4 mm. long, 3 mm. wide and 1 mm. thick. An egg was above one mass of pollen, the ends of which touched the pollen but the body was curved like a bow above it. The walls of the cells were exceedingly smooth inside and unglazed, as were all the other parts of the nest.

The cells were constructed and provisioned from the top of the nest downward; the most mature larva being nearest the outside. All evidence at hand pointed to the fact that the bees of the nest were working in close association one with another. It appears that not only the tunnel but also the nest containing the cells were made and used by more than one bee but whether or not more than one female helped in a given unit of work could not be ascertained.

One of the larvae brought to the laboratory pupated, without spinning a cocoon, on August 6th, but died just before reaching maturity. The cocoon, found in the upper cell, probably contained a parasite, which unfortunately never reached maturity.

STUDIES IN THE MELYRIDAE, NO. 9. (COLEOPTERA.)

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Two of the species described below were discovered very recently and constitute a very interesting addition to our Melyrid fauna. The individuals or units of a species vary more or less and this variation makes the work of the taxonomist rather uncertain and difficult as regards the characterization of a species, until considerable series has been studied from some single locality. When a knowledge of the range and degree of variation has once been obtained, the systematist can proceed with greater confidence as regards the status of the species he describes. Collectors should bear in mind the need of series for the study of variation.

Listrus inyoensis n. sp.

Form elongate oblong-oval to feebly oblong-ovate, about three times as long as wide. Color black; second joint of antennae rufous beneath, tibiae and tarsi rufo-piceous. Luster somewhat shining and more or less feebly tinged with cupreous.

Pubescence nearly uniform in distribution and cinereous in color, hairs recumbent, moderately dense, almost completely hiding the general surface; immaculate to occasionally with a subapical transverse row of four distinct or more or less evanescent small black macules on the elytra; lateral pronotal fimbriae rather short, pale, very regular and posteriorly arcuate, those of the elytra longer, less posteriorly arcuate and less conspicuous behind the middle. Hairs of the abdomen longer, finer and closely recumbent, those of the sterna a little coarser and denser.

Head subquadrate, about a third wider than long, three-fourths as wide as the pronotum; frons almost plane, feebly and broadly impressed throughout, rather densely punctate, punctures small, separated by a distance equal to one to one and

one-half their diameter, intervals somewhat indented, especially anteriorly, muzzle short. Eyes moderately prominent, evenly convex as viewed from above, slightly unevenly oval and a little oblique as viewed from the side, facets moderately small. Antennae similar in the sexes, of moderate length and stoutness, about attaining the pronotal basal angles, last three joints slightly incrassate; second joint oval, third obconical and about as long as fourth, the latter subtriangular, fifth triangular, more prominent anteriorly than the others, seventh to the eighth inclusive also triangular and as long as wide, ninth and tenth more rounded, eleventh pointed ovate and about a half longer than wide, not wider than the tenth.

Pronotum about a third wider than long, not as wide as the elytral base across the humeri; apex transverse in feeble circular arc, apical angles rounded, continuously so with the broadly arcuate sides, which are evenly continuous with the broadly arcuate base, basal angles absent; disk evenly and moderately convex, scarcely more declivous antero-laterally, densely identato-punctate, lateral margin serrulate.

Elytra about twice as long as wide, humeri rounded, sides parallel, evenly arcuate in apical third with the parabolically rounded apex; moderately and evenly convex on the disk, more strongly and arcuately declivous at the sides; rather densely punctate, punctures a little larger than on the pronotum and slightly impressed, the surface shows some evidence of undulations, punctures separated by a distance equal to one or two times their diameter.

Abdomen quite densely punctate, punctures small. Legs moderate in length and stoutness, metafemora similar in the sexes, straight and not inflated.

Male.—Sides of elytra not arcuate in basal two-thirds. Metafemora about attaining the apex of the third ventral segment. Fifth ventral arcuately emarginate at apex, surface impressed in about middle third, impression black with floor shining, smooth or more or less granulate, margins clothed with blackish hairs, fourth ventral with a small patch of similar black hairs at middle of apex and there continuous with those of the impression.

Female.—A little more robust, sides of elytra a little more arcuate, slightly widest behind the middle; pronotum widest just behind the middle. Abdomen more convex, fifth ventral broadly but not strongly arcuate at apex.

Measurements.—(Types) Length 3-3.3 mm.; width 1-1.5 mm.

Holotype.—male (No. 2971), and *allotype,* female (No. 2972), in the author's collection, Museum California Academy of Sciences. Collected at Lone Pine, Inyo County, California, by Ralph Hopping, on May 23, 1930. Paratypes in the author's and Mr. Hopping's collection.

Distribution.—This species has been taken at Bishop, and at Big Pine, June 17, 1929, by R. L. Usinger and E. P. Van Duzee, all from Inyo County.

Inyoensis belongs to that Section of species which have the fifth ventral abdominal segment modified at apex, and to the *Salicis* Group of that Section, on account of the elytral maculation consisting of isolated maculae that tend to obsolescence and should precede *salicis* Blais. in our lists. *Inyoensis* is frequently immaculate, otherwise there is a more or less distinct transverse row of four discrete macules at apical third of the elytra, rarely there might be slight evidence of a dot or two at middle, representing the usual median transverse

fascia; in other specimens there is a tendency for an appearance of the fasciae and macules toward the base, at all times the maculation is weak.

The immaculate specimens of *inyoensis* superficially resemble those species belonging to the *Senilis* Group, but here the fifth ventral is unmodified at apex, the pronotum is opaque and extremely densely punctato-rugulose. See the author's Synopsis of the Species of Listrus, Stanford Univ. Pub., Univ. Series Biol. Sciences, vol. 1, No. 3, June 1921, p. 175.

Trichochrous varipes n. sp.

Form elongate oblong-oval, moderately parallel and somewhat robust, a little more than two and a half times longer than wide. Color black with an aeneous tinge; basal antennal joints rufous, the first black, distal joints more or less rufo-piceous; legs rufous, dorsal surface of the femora more or less tinged with piceous, occasionally nearly entirely piceous.

Pubescence cinereous with a slight flavous tinge, moderate in length, not closely recumbent, rather dense but not entirely hiding the general surface; on the elytra sparsely intermixed with longer semi-erect pale hairs which become more erect and bristling on the sides, especially on the humeri where a few long black setae are present. On the head and pronotum the pale hairs are more recumbent, on the latter sparser in the central area toward which they are directed, on both sparsely intermixed with long erect bristling black setae, not forming a regular fringe on the lateral margins of the pronotum; fimbriae of the elytral margins moderate in length and not closely set. Body beneath clothed with somewhat longer and finer recumbent hairs, which are a little denser on the prosternum and parapleura.

Head small, distinctly narrower than the pronotal apex, a little wider than long and suboval in outline; frons nearly plane, feebly and broadly impressed each side before the eyes from the epistomal base, punctures moderate in size, somewhat sparse, regular and separated by a distance equal to one to three times their diameter. Eyes large, feebly convex, almost coinciding with the curvature of the sides of the head; sides of the front distinctly beaded, the bead continuing along the dorsal border of the eyes. Antennae moderate in stoutness, rather short and similar in the sexes.

Pronotum strongly convex, about a third wider than long; apex nearly transverse in circular arc; apical angles obtusely rounded; sides very moderately arcuate, noticeably convergent anteriorly, broadly and feebly sinuate before the basal angles, the latter subacute and slightly prominent laterally; base broadly arcuate, about a third wider than the apex; disk somewhat shining, rather strongly declivous antero-laterally, punctures small, well defined, quite sparse and separated by a distance equal to two, three or four times their diameter; lateral margins rather sharp and not beaded.

Elytra moderately strongly convex, about three-fourths longer than wide, arcuately declivous laterally, humeri rounded and somewhat tumid, slightly more prominent than the sides, adjacent surface within rather broadly and slightly impressed against the base; sides parallel to slightly arcuate, each elytral apex well rounded at the sutural angle, conjointly broadly rounded; base noticeably wider than the pronotal base; punctures towards base slightly larger than those towards apex, separated by a distance equal to two or three times their diameter;

lateral margin very narrowly reflexed in basal half.

Abdomen finely and rather densely punctate. Legs moderate in length and rather slender, tarsi moderately long; metatarsi three-fourths as long as their tibia.

Male.—Less convex above, head slightly larger; pronotum relatively slightly less robust; abdomen more densely and somewhat more distinctly punctate, segments two to four inclusive subequal in length, fifth a little longer and truncate at apex.

Female.—More convex above, head smaller, prothorax more robust and noticeably narrower than the elytral base. Abdominal punctures smaller, segments two to four as in the male, fifth nearly twice as long as the fourth and rather strongly arcuate at apex.

Measurements.—(Types) Length 4.5-5 mm.; width 1.5-2 mm.

Holotypes, female (No. 2973), in the author's collection, Museum California Academy of Sciences.

Allotype, male, in Ralph Hopping's collection, Vernon, B. C. Paratypes in both collections.

Type locality.—Coalinga, Fresno County, California. Collected by Mr. Hopping, on May 11, 1930. Ten specimens studied.

According to Casey's synopsis *varipes* is to be placed after *tectus,* but is at variance with that species on account of the rufous legs and pale erect setae of the elytra. The wording of the synoptic table should be changed to read: Legs more or less dark to rufo-piceous, otherwise the rufous legs places it with *crinifer, hirtellus* and *fulvescens,* from which it differs markedly as indicated above.

Menovectura n. Gen.

Ungual appendages well developed, oblong and more or less rounded at apex, mutually equal, as long as the claws and attached throughout their own length; pronotum with submarginal lines which do not quite attain the apex or base; epipleura moderately wide and horizontal opposite the sterna, becoming somewhat inflexed opposite the middle of the first abdominal segment, then rapidly narrowing to become evanescent at apex of the third ventral at considerable distance from the elytral apex. Anterior tibiae without external spinules.

Head not elongate, gradually narrowed behind the eyes to form a short neck; muzzle very short, likewise the epistoma, labrum well developed. Eyes situated at middle of sides of head, very convex and prominent, evenly rounded to very slightly oval. Antennae of moderate length, attaining middle of the prothorax, last five joints gradually and slightly incrassate.

Lateral margins of the pronotum serrulate and fimbriate, the fimbriae very short, regular, posteriorly arched, resting against the apices of the serrules; base broadly lobed. Legs moderately slender. Abdominal sutures transversely straight.

Genotype: *Menovectura serrulata* Blaisdell.

The species on casual examination greatly resembles *Pseudallonyx plumbeus* Lec., the form, pubescence and color being quite similar,

Menovectura serrulata n. sp.

Body cuneiform, about three times as long as wide, head and prothorax relatively small. Color black; legs rufo-testaceous, tarsi rufo-piceous, pro- and mesocoxae in greater part pale. Luster subopaque with a feeble aeneous tinge in certain lights.

Pubescence cinereo-plumbeous in color, closely appressed to the surface throughout, short and somewhat coarse, evenly distributed, not entirely obscuring the general surface, hairs of the under surface a little longer and finer, a little denser and more cinereous on the sterna, pro- and parapleura. Lateral fimbriae of pronotum and elytra extremely short.

Head about as long as wide, across the eyes wider than the pronotal apex; frons plane, broadly and feebly impressed along the junction of lateral and middle thirds, slightly tumid at middle against the epistomal base; very densely and rather finely punctato-rugulose and subasperate. Eyes very prominent and semicircularly convex, rounded when viewed from the side, facets moderately small. Antennae attaining the middle of the pronotum, rather slender, outer five joints noticeably incrassate, second joint oval, third cylindro-obconical, a little longer than the fourth, the latter more obconical, fifth larger, subtriangular and more prominent anteriorly, sixth and eighth subequal in size, smaller and shorter than the seventh and ninth, the latter and tenth more rounded, thicker and about as long as wide, eleventh ovate, a half longer than wide. Pronotum about a fourth wider than long, apex truncato-arcuate and equal to the length, angles rounded with the sides, the latter feebly arcuate, very moderately convergent from base to apex, broadly and feebly sinuate before the middle, less so before the basal angles, which are acutely subrectangular, lateral margins distinctly serrulate; base broadly and arcuately lobed, sinuate within the angles which are on a line with base of the lobe and there equal to the greatest width; disk moderately convex, surface slightly iregularly undulate when viewed at a tangent, densely, rather finely punctato-rugulose and subasperulate, the submarginal excavated lines moderately strong, evanescent near apex and base, submarginal area moderately concave, rendering the margin somewhat explanate.

Elytra a little less than twice as long as wide, gradually wider to about apical third, apex obtusely subogival, sutural angles narrowly rounded; base distinctly wider than the pronotum, humeri broadly and evenly rounded, feebly tumid; sides straight and declivous, apparently impressed in little more than basal third behind the humeri, rendering the margin there distinctly explanate, thence the sides are gradually more dilated and arcuately declivous rendering the margin very narrow; disk moderately convex, densely punctate, punctures very small, surface more or less obsoletely subasperulate.

Body beneath densely and finely punctate. Legs rather slender and somewhat long; tibial spurs small and scarcely recognizable from the apical spinules. Metatarsi nearly as long as their tibia.

Male.—Narrower, form more subcuneately elongate ovate; antennae usually entirely black; fifth ventral abdominal segment rather truncato-arcuate at apex. Abdomen less convex.

Female.—More dilated posteriorly and more cuneiform. Antennal joints 2, 3

Above—TYPICAL GROWTH OF PSORALEA MACHROSTARCHA.

Below—EVERY MAIN STEM MINED BY PAPAIPEMA ANGELICA.

and 4 usually pale; fifth ventral rather strongly arcuate at apex. Abdominal segments subequal in length, surface more convex.

Measurements.—(Types) Length 3-3.5 mm.; width 1.3-1.5 mm.

Holotype, male (No. 2974), in my own collection, Museum California Academy of Sciences.

Allotype, female in the collection of Ralph Hopping, Vernon, B. C. Paratypes in both collections.

Type locality.—Caliente, Kern County, California. Collected by Mr. Hopping, on April 24, 1930. Nine specimens studied.

The generic description gives the differential characters. In *Pseudallonyx* the ungual appendages are extremely unequal, likewise *Allonyx, Vectura* and *Leptovectura.*

THE PAPAIPEMA SPECIES OF THE PACIFIC COAST. (LEPIDOPTERA).

BY HENRY BIRD,

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While it is not unlikely that additional species will be discovered in the Pacific Coast region, perhaps well northward in Alaska, the *Papaipema* fauna which reaches the Atlantic seaboard of our country will doubtless remain much the richer comparatively.

Furthermore, topography in the former area must play an important part in surrounding these species with more or less endemic characteristics of centralization. The literature concerning these western forms is both scanty and scattered and it may be helpful to bring it in resumé, since the additional information can be produced in one instance.

The generic concept holds well with the species and the larval habit, both of the boring propensity and choice of particular food plant, apparently runs true to form and periodicity. As may be expected, their individual preferences bring added plant genera to the floral bill of fare, attractive to the group as a whole.

In historical sequence the species arrange as follows.

P. angelica Sm. In the early 'eighties, D. W. Coquillett was in southern California concerned with economic problems of the citrus growers and collected in various entomological lines. At Anaheim in 1882, he encountered pupae of *angelica,* successfully reared some moths, and in the following year met with it at Los Angeles.

His specimens were deposited in the U. S. National Museum, though it was not until 1899 that J. B. Smith actually named the species at the occasion of publishing his "Revision of Hydroecia". Later in the same year, Coquillett published a note giving the name of the foodplant, the pupation habit and the dates for emergence of the adults.

In the interim the literature seems to carry no further additional information and the efforts of the writer to secure a re-discovery through the co-operation of local entomologists has been without success. Last summer, an elder son, Roland Thaxter Bird was motoring in the West, and when learning

he would be at Los Angeles around August first, it was suggested that he try to locate the foodplant, *Psoralea machrostarcha*, with the possibility of meeting its borer, then to be at about pupal stage. The plan met with success and thanks to airmail service, in a fortnight from making the suggestion, an *angelica* adult crawled forth from a mailing tube, having emerged on the eastern trip from its very type locality.

From the heavy infestation, the larval work was easily located in a swampy area at about sea level in the Huntington Beach section, where the plant's tolerance of salinity was strikingly obvious. Quoting from my son's notes:

"This *Psoralea* species grows in large clumps of fifteen to twenty heavy stalks, covering with the dead stems of the previous year, an area of three to four feet in diameter. The stronger plants attain six feet or more in height. A mined stem is easily picked out since the tip of the mined stalk dies back a few inches and the growth of the plant upward is then concentrated in the branches. The borer makes a hole at some point though this is not often noticeable. Very little if any frass is thrown outside. The stalks are hollow and it collects at the bottom near the roots where the hollow ends. Water willows of some kind, cat-tails, several coarse sedges, and a sort of goldenrod were ecological associates. Nettles are much in evidence, growing right among the *Psoralea* clumps at times."

Botanical references record *machrostarcha* as being one of the commonest Psoraleas of the cismontane Californian region. It occurs along rivers and follows canyon bottoms in the mountains up to 3000 feet. Found also on salt meadows; always in richest soil. The roots are said to have furnished a tough fibre to the aboriginal Indians.

Both the plant and its boring tenant are doubtless ancient denizens of the stations under examination. Because this area is nearly surrounded by oil wells and storage tanks, fire—that implement of ruthlessness in the hand of modern white man—has had a sufficient financial contingency to have been withheld from this swampy section.

That retrospect of biological happenings which is possible with *Papaipema* when pupation normally occurs in the gallery, by observation of the borings after adult emergence, permits the following tabulation.

Judging from eastern observations, the data reflecting *angelica* conditions were unusual since more than half of the number of larvae succeeded. However, if similar checking were continued over a period of five years to total a thousand observed individuals, very different results might be expected, for the pendulum of eventualities swings markedly in varying years. With some of the easily followed eastern species but five per cent or less, of a thousand, are successful in the period from early larvae to adult moth, when records are spread over a number of years.

This compilation further shows absence of mammal attack and may be a feature with this species though depredations of this sort are apt to be irregular and much localized. That seventy-four stems showed deserted burrows

may indicate a larval change from such stems to others; or early parasitism may have left no clue; or less likely, these larvae may have left for pupation elsewhere.

Report on *angelica* conditions along La Bolsa Creek near Huntington Beach, Cal., Nov. 10, 1930.

	Successfully emerged	Fell to parasite No. 1	Fell to parasite No. 2 in early larval stage.	Parasite undetermined	Fungus	Field mice or other mammals.	Early larvae fell to undetermined cause.	Undetermined causes, pupal stage.	TOTALS	Empty stems found mined.
Locality No. 1.	19	13		4	3		6	6	51	16
Locality No. 2.	27	16	1	6			1		51	21
Locality No. 3.	34	9	2	1			4	2	52	20
Locality No. 4.	16	6	1	1	1			2	27	7
Locality No. 5.	17	2	2	1			1	1	24	10
Totals	113	46	6	13	4		12	11	205	74

Two rather large Ichneumonids were obviously primary parasites, and a small dipterous scavenger larva is very common in the burrows, passing the winter in puparium. Other insects occasionally find the bored stems inviting; Arctiid-like larvae spin cocoons therein, and a medium-sized wasp, presumably some Sphecid, used the hollowed stalk as a brood chamber, storing it full of orthopterous insects which seem to be entirely tree crickets. Its pupa overwinters.

The adult moth is typically Papaipema in its markings; the stigmatal spots are outlined but not filled in with scales. The primary ground color varies from a dull yellow, when the moth resembles *cataphracta* Grt., to a pale mixed brown when it is hard to differentiate from the immaculate variety of *Emboloecia sauzalitae* Grt. Indeed the relationship is close to *sauzalitae,* for *angelica* has a slight development of the frons, midway in detail with the smooth Papaipema type and the frontal ridge whereby Grote thought his species entitled to a different generic setting. Their mature larvae apparently are in full accord with the major group, and the peculiar Papaipema type of male genitalia holds with both the *Psoralea* feeder and the Grote species.

Having knowledge of the agreement of these seemingly more fundamental generic details, causes the question of separation in the case of *sauzalitae* with its mere frontal development, to become a matter of individual opinion. In many lepidopterous genera this feature alone is not accorded such rank. The male genitalia, fully typical with at least thirty-five congeners, differs in

the detail wherein the curved, protruding clasper is smooth and not decorated with saw-tooth projections.

The ova obviously overwinter; larvae are likely emerged by May 1. for the larval period may be longer than with species at the latitude of New York.

The mature larva, smooth, cylindric and fully congeneric, in its coloration is of the soiled whitish semi-transparency common to the group and superficially looks much like *furcata* in similar stage.

A faint depth of shading on the first four abdominal segments gives intimation of the probability of the dark girdle being existant in the early stages. The head now shows no side marking but the thoracic plate still holds its linear, lateral blackish edging.

The tubercles are unusually well defined for the stage and blackish in color; on first three abdominal joints I is larger than on the four succeeding ones; to joint ten, IV predominates, being fully three times the size of the spiracle; on this latter joint there is the major complement of five tubercles surrounding the spiracle, though IV is here reduced. Larvae attain a length of 40 to 42 mm.

The illustrations indicate the flagrant operations of *angelica*.

P. insulidens Bird.—1902. Both the description of the species and the discovery of its larva by Mr. F. M. Jones in 1918, have been chronicled in this magazine. The type material came from Vancouver Is. B. C., while the larval encounter established its distribution southward to at least Sisson, Cal. *Senecio hydrophyllus* Nutt. is the preferred foodplant and in adding this, another noteworthy genus, it illustrates how widely the floral list is invaded by specific, individual selection.

In the adult the common habitus prevails; it belongs with the yellow forms, yet is readily separable.

P. limata Bird.—1908. Further than the bare description of the moth which has appeared in this magazine, no additional information seems available concerning its biological status. That the larva is not a Fern-feeder, the stigmatal pattern would indicate, but how far elimination must proceed in order to run down the foodplant, may be, as with some of the eastern species yet incognito, a trying task.

The moth possesses the conventional pattern, groups with the yellow series and is a pretty species, easily distinguished.

P. pertincta Dyar.—1920. Information concerning this species at the time of its description gave reference to the foodplant, *Lupinus polyphyllus* Lind., one of the largest of the western Lupines.

Its discovery is to credited to Mr. L. P. Rockwood who encountered the larva at Forest Grove, Oregon, and successfully reared the adult.

Subsequently through knowledge of the foodplant, Prof. S. E. Crumb has made an extended larval acquaintance in the vicinity of Puyallup, as well as at several other stations in Washington.

The moth autopically fits in the *marginidens-merriccata* series and in all stages is congenerically typical.

Available emergence records date Aug. 22-Sept. 5.

Two other species of wide distribution and northern range may attain the Coast, although not yet so recorded.

Following its preferred and widespread foodplant, *Heracleum lanatum*, *P. harrisii* may reach even the Alaskan Coast, for it ascends to elevated mountain meadows in the Rockies, is recorded from Alberta and thence across country to Nova Scotia. Dr. Roland Thaxter first discovered its larva in Maine, some time in the late 'seventies.

Of less known range, *P. pterisii* may gain unexpected distribution through the ubiquitous character of its special fern, *Pteridium aquilinum*, whose confines are hard to limit geographically and which flourishes in great luxuriance in parts of Oregon. Because this plant has assumed a serious economic problem as a weed in sections of Australia, the local Agricultural Department is considering the possibility of control through biological processes—the turning of its insect patrons against it. In this category *pterisii* is receiving consideration; whether the insect would conform to the reversed seasonal conditions is of course unknown.

Were it a root miner as is *inquaesita* and *stenoscelis*, much more injury or control could be expected of it.

In this connection it may be recounted that with the exception of *purpurifascia* in the root of Columbine, and *appassionata* in the small root of the northern Pitcherplant, *Papaipema* species do not kill outright nor generally seriously damage their host plants.

THE EASTERN NORTH AMERICAN SPECIES OF THE GENUS EPHEMERELLA AND THEIR NYMPHS (EPHEMEROPTERA)*

BY J. MCDUNNOUGH,
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In a recent paper (1931, Can. Ent., LXIII, 30 *et seq.*) I reviewed the *bicolor* group of the genus *Ephemerella* and in the present one I purpose dealing with the remainder of our eastern species and tabulating the results of breeding experiments, carried on during the past three years by Messrs. Walley, Milne and myself, as far as they relate to this genus.

Leaving out of consideration for the present the members of the *bicolor* group, there have been thirty-one names proposed for *Ephemerella* species from eastern North America; further one holarctic species, *aurivillii* Bngtssn. (*norda* McD.). has been found to occur in Ontario and Quebec Labrador. Of these species *consimilis* Walsh and *unicornis* Needh. still remain unidentified; the former was described from a single male from Rock Island, Illinois, the type has been destroyed and the description is too brief to be of much service; the latter name was based on a male subimago from Elkhart, Indiana, and the distinguishing character given, *viz.* the presence of a small horn-like protuberance on the mid-anterior section of the mesothorax, occurs sporadically in several species very similar in the subimago stage. Until extensive collections can be made in the type localities of these two species their identity must for the present remain problematic.

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*Contribution from the Division of Systematic Entomology, Entomological Branch. Dept. of Agric., Ottawa.

Five of the above thirty-one names become synonyms; *atrescens* McD. falls to *deficiens* Morg., *inflata* McD. to *lata* Morg., *bispina* Needh. to *fuscata* Wlk., *vernalis* Banks (♂) and *feminina* Needh. (♀) to *rotunda* Morg. Of the remainder, five species are still unknown to me in the nymphal stage; these are *frisoni* McD. described from Illinois and belonging in the *serrata* group; *molita* McD., known only from two female specimens from Quebec Labrador and New Brunswick; *excrucians* Walsh, *semiflava* McD. and *fratercula* McD. which all belong to the typical section of the genus (type, *excrucians*) and, judging by the similarity of the male genitalia in the group, will probably be found to possess nymphs very closely allied to those of *invaria* and *rotunda*.

Various attempts have been made to separate off from this rather complex group individual species whose characters have at the time been considered of sufficient importance to warrant subgeneric or even generic names. My own studies in *Ephemerella* nymphs have not proved to my satisfaction the correctness of the existing subdivision; on the contrary it has seemed to me as if the importance of individual characters, caused largely by environmental conditions during the nymphal stage, has been overemphasized. When we find that a nymphal character, such as the notched frontal shelf, which is said to characterize the subgenus *Eatonella* Needh. (1927, Ann. Ent. Soc. Am. XX, 108) is present in one nymph (*fuscata* Wlk.) and not in another one (*tuberculata* Morg.) but that the two adults are so closely related in genitalic structure and other details as to be almost inseparable, we are forced to ask ourselves whether the separation of these two obviously closely related species under different subgeneric titles is helping to put our classificatory system on a sounder basis than it possessed previously. Does it not rather seem as if an individual character which crops up in isolated instances among a group of nymphs capable of extraordinary structural diversification has been accorded greater taxonomic value than it deserved?

I am a firm believer in the axiom that the only completely satisfactory classificatory system will be one in which *in all stages* the characters dovetail in with and supplement one another, but when I find, as I have shown for *Chitonophora* Bngtssn. (1930, Can. Ent. LXII, 55), and as anyone by a study of the present illustrations can demonstrate to their satisfaction, that, by using solely the nymphal characters said to pertain to the genus or subgenus, a completely different arrangement of our North American species is obtained to one which is based on the given adult characters, then, I maintain, such characters are not capable of being used for purposes of subdivision other than specific.

Now that the larger proportion of our North American species of *Ephemerella* can be recognized in both the adult and nymphal stage a certain grouping or arrangement of species according to characters drawn from *both* stages seems possible. The typical section of the genus would comprise the eastern species *excrucians* Walsh, *semiflava* McD., *dorothea* Needh., *rotunda* Morg., *invaria* Wlk., *subvaria* McD. and *fratercula* McD. as well as the western *inermis* Eat. and *infrequens* McD. In all these species the male adults show a very similar type of genitalia, the united penes broadening out somewhat apically with the lateral edges projecting in the form of short blunt processes,

thus forming the sides of a shallow excavation; there is an armature of minute spines scattered over the apical section (*vide* Can. Ent. 1925, LVII, 169, Pl. 4, fig. 1; Trans. Roy. Soc. Can. 1925, (3) XIX, Sec. 5, Pl. 1, figs. 5, 6). The apical portion of the second joint of the forceps may or may not be enlarged but this is purely a specific character and has no value in a generic or subgeneric sense; the third joint is short and conical.

The nymphs, as far as known, belong to a rather generalized type and are difficult to separate; the head and thorax are smooth, the legs show no particular modifications; overlapping gills occur on segments III-VII and the lateral edges of the abdominal segments are somewhat flattened with the posterior angle forming a slight projection; the abdomen dorsally may be smooth or provided with a double row of small, flat spines, quite distinct from the erect tubercles found in other members of the genus. They frequent the swifter parts of streams and are most frequently met with along the banks among grass roots and refuse.

The three species *aurivillii* Bngtssn. (*norda* McD.). *septentrionalis* McD. and *needhami* McD. must be regarded, to my mind, as slight modifications of or developments from this typical section. In the male genitalia (*vide* Can. Ent., 1924, 223, Pl. 5, fig. 5; 1925, 171, Pl. 4, figs. 2, 3) the lateral apical edges of the penes have been drawn out to form longer and sharper projections; the armature of small spines is still present in a somewhat modified degree in the first two species but lacking in *needhami*, which further shows none of the apical lateral expansion of the typical section. Whilst in *aurivillii* there has been no change in leg structure we meet with a lengthening of the male fore-tibia in *needhami* which is carried to a remarkable extent in *septentrionalis*, where all the tibiae are extraordinarily long.

The nymphs of all three species still show smooth heads and thoraces; in general appearance *aurivillii* bears the greatest resemblance to the nymphs of the previous group, the postero-lateral edges of the abdomen being rather more drawn out and the flat spines of the dorsum somewhat longer; in *needhami* a development of strong erect dorsal abdominal tubercles has occurred whilst in *septentrionalis* we find the same abnormal leg development that is present in the adult, the nymphs presenting a very spidery appearance. All these species show a great preference for living among grass-roots or mossy growths below overhanging banks and are seldom found beneath stones.

A second compact group of quite small species includes *deficiens* Morg., *serrata* Morg., *serratoides* McD., *sordida* McD., and *frisoni* McD. These are characterized in the male genitalia by the presence of a small barb-like process on the lateral apical edge of the penes, projecting dorsally and best seen when viewed from the side; the forceps are of the normal type with short third joint and no apical swelling to the second one (*vide* Trans. Roy. Soc. Can. 1925, (3) XIX, Sec. 5, 212, Pl. 1. fig. 1). The nymphs have smooth or at the most slightly roughened heads and thoraces and overlapping gills on segments III-VII; with the exception of *deficiens*, they show a double dorsal abdominal row of broad, short, blunt tubercles or warts, covered with short spicules and based on the posterior margin of the segment; the length of the postero-lateral prolongations of the abdominal segments is variable and the tails are provided with whirls of short spinules, situated at the segmental joints.

A third section comprises *fuscata* Wlk., *tuberculata* Morg., *lata* Morg., *cornuta* Morg., *cornutella* McD., *depressa* Ide and several of our western species of the *coloradensis* group. The adults are rather heavy and clumsy in appearance and blackish in coloration. In the male genitalia the third joint of the forceps is at least twice as long as wide and the second joint is either strongly curved or irregularly swollen; the penes are quite simple, narrowed apically with a small apical notch and bent upwards almost at right angles about halfway between base and apex (*vide* Bull. 86, N. Y. Stat. Mus., 1905, Pl. x, fig. 9; Trans. Am. Ent. Soc., 1923, XLIX, Pl. viii, figs. 2 and 4). The nymphs are very highly specialized and show a great amount of diversification in respect to head-structures and abdominal tubercles but all agree in having broad and tuberculate anterior femora and overlapping gills on segments III-VII, (Morgan's statement that in *lata* and *tuberculata* the gills are on segments III-VIII is a *lapsus calami*); they may be very hairy or almost glabrous but the tails, in contrast to those of the preceding group, are clothed with long hairs and not spinose. They are all distinctly inhabitants of swift water and occur under rocks or submerged pieces of wood, frequently at considerable depth and in places where the current is full of silt.

Attenuata McD. and *simplex* McD. are two rather aberrant species which appear to connect up the *fuscata* with the *bicolor*-group. The male genitalia of the former species show a greatly drawn-out third joint of the forceps whilst in *simplex* this joint is scarcely longer than broad. The western *margarita* Needh., known definitely only from the nymph, also belongs here. The nymphs agree in possessing overlapping gills only on segments IV-VII, those of III being lacking; in other respects, as a reference to the following key to the nymphs will show, there is only a general similarity between them.

The *bicolor*-group forms the last section in the genus. I have already fully discussed this group and would only note the distinguishing features of the nymphs are the presence of gills on segments IV-VII, covered almost entirely by the operculum of the fourth segment, and further the prolongation of the postero-lateral angles of the abdominal segments into long spines. The western *hecuba*, for which Needham has proposed the subgeneric term, *Timpanoga*, is probably only an extreme development of this type.

In the following key to nymphs I have omitted the species of this last section; a key to these may be found in my previous paper.

KEY TO KNOWN EASTERN SPECIES OF EPHEMERELLA NYMPHS

1. Gills on segments 4-7 2
   Gills on segments 3-7 5
2. Gills almost entirely covered by operculum of 4th segment. *bicolor* group
   Gills overlapping but not covered by operculum 3
3. Abdominal tergites without double row of tubercles ..... *simplex* McD.
   Abdominal tergites with double row of tubercles projecting from rear margin of segment 4
4. Vertex of head with pair of strong tubercles; prothorax similarly armed; length 10 mm. ..... *attenuata* McD.
   Vertex of head unarmed; tubercles of prothorax reduced to slight warts;

length 5-6 mm. ..... *margarita* Needh.

5. Head with a broad notched frontal shelf; all femora broad and flat ..... *fuscata* Wlk.

Head without notched frontal shelf 6

6. Fore femora much broader than those of hind pairs of legs, with anterior margin toothed or tuberculate 7

All femora of more or less equal thickness; no teeth on front pair..... 10

7. Vertex of head with pair of long tubercles ..... *tuberculata* Morg.

Vertex of head smooth 8

8. Head with triangular ledge projecting over base of each antenna.. *lata* Morg.

Head with curved, horn-like projection arising at base of each antenna.... 9

9. Size large (body length 10 mm.); small tubercle about middle of lateral edge of pronotum; mid and hind tibiae moderately long..... *cornuta* Morg.

Size small (body length 6-7 mm.); lateral edge of pronotum almost smooth; mid and hind tibiae relatively considerably shorter..... *cornutella* McD.

10. Legs noticeably long and spidery, size 7-8 mm..... *septentrionalis* McD.

Legs of normal length and thickness 11

11. Abdominal tergites with double row of elevated, finger-like tubercles ..... *needhami* McD.

Abdominal tergites otherwise 12

12. Abdominal tergites entirely without tubercles or spines; small species... 13

Abdominal tergites with at least traces of two rows of spines or tubercles.. 14

13. Color blackish with frequently a pale median thoracic stripe; caudal setae with whorls of short spines situated intersegmentally..... *deficiens* Morg.

Color brown with sprinkling of pale dots; caudal setae with apical half clothed with long fine hairs..... *dorothea* Needh.

14. Armature of abdominal tergites consisting of short, sharp, flattened spines, often much reduced; caudal setae clothed with long hair in apical section; size moderate to large 18

Armature of abdominal tergites consisting of small, rounded, spicule-bearing warts; caudal setae with whorls of short spines only; size small.... 15

15. Prothorax with pair of small median warts near posterior margin; a lateral row of black dashes ventrally..... *serrata* Morg.

Prothorax smooth 16

16. Posterolateral edges of abdominal tergites 8 and 9 strongly flattened and drawn out into long spines; no ventral maculation..... *sordida* McD.

Abdominal tergites 8 and 9 not drawn out into long spines; ventral maculation of dark dots and dashes..... 17

17. Color brown with heavy sprinkling of pale dots..... *serratoides* McD.

Color black with white patches on head below antennae and median and submedian thoracic pale stripes; abdominal tergites 5 and 6 whitish with pink median and submedian dashes..... ? *serratoides* form

18. Posterolateral edges of abdominal tergites drawn out into long spines, that of the eighth segment being fully twice as long as wide at base; legs moderately long, hind tibia slightly longer than femur.... *aurivillii* Bngtssn.

Posterolateral edges of abdominal tergites less drawn out, the spine of the eighth segment being scarcely longer than broad at base; legs considerably

shorter with hind tibia shorter than or subequal to the femur.....19

19. Abdominal spining much reduced, at times obsolescent.....*invaria* Wlk.
Abdominal spines short but distinct, larger species.....20

20. Abdominal spines quite short; color evenly dark with a double row of pale spots on abdominal tergites at base of spines.....*rotunda* Morg.
Abdominal spines longer; color on abdomen more variegated, tergites 6 and 7 being at times almost entirely pale .....*subvaria* McD.

Section I (typical section)

The eastern species of this section may, as already noted, be divided into two groups. In the first, which includes *excrucians* Wlsh. and *semiflava* McD., the second joint of the male forceps is not enlarged apically as is the case in the second group, comprising *dorothea* Needh., *subvaria* McD., *rotunda* Needh., *invaria* Wlk. and *fratercula* McD. The three modified species, *aurivillii* Bngtssn., *septentrionalis* McD. and *needhami* McD. I place at the end of the section as noted in the introduction.

Ephemerella excrucians Walsh

Ephemerella excrucians Walsh, 1862, Proc. Acad. Nat. Sci. Phil. 377; Eaton, 1884, Rev. Mon. Rec. Ephem. 130; McDunnough, 1925, Can. Ent. LVII, 169, Pl. IV, fig. 1; Ide, 1930, Can. Ent. LXII, 211.

I am basing my identification of this species on the specimens in the Cambridge Museum which I believe to be the only authentic Walsh material now in existence. Needham's identification is something entirely different and probably contains a mixture of species as I have previously noted.

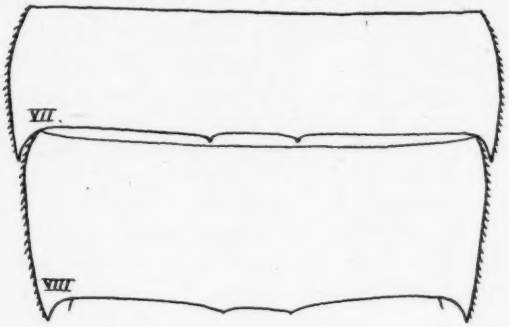
I would call particular attention to the fact that Walsh definitely states that the eyes are *egg-yellow* in the living male, which is rather a rare occurrence and should render the species readily identifiable when collections can be made at Rock Island, Ill., the type locality.

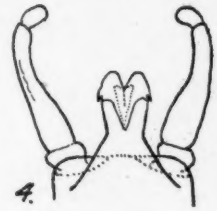
Specimens before me from the Upper St. Lawrence river (Kingston, Prescott) as well as single males from Knowlton, Que. and Fredericton, N. B. agree in genitalia with a topotypical specimen in the Canadian National Collection, collected by Walsh in 1863, which I consider identical with the male specimen at Cambridge, marked by Banks as the type. Our St. Lawrence specimens are, however, duller in color and, as far as I can tell from dried material, more likely to have red-brown eyes when living than egg-yellow ones; there is therefore a likelihood that they are not Walsh's species but until we can secure data on the nymphs I prefer to let the matter rest. The nymph is unknown.

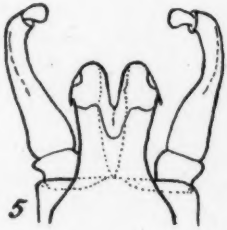
Ephemerella semiflava McD.

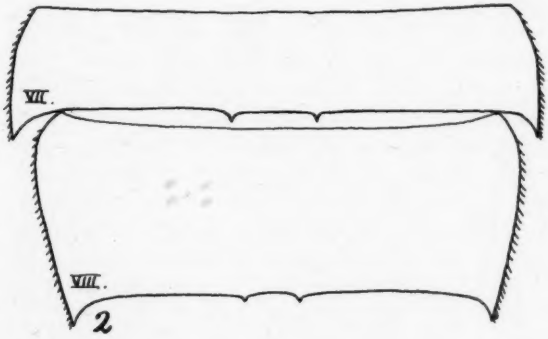
Ephemerella semiflava McDunnough, 1926, Can. Ent., LVIII, 300.

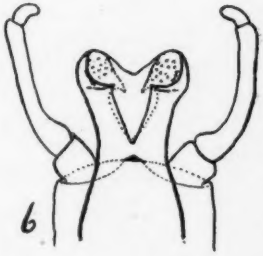
I believe now that there is a great likelihood that this species will fall as a synonym of *excrucians* Walsh. The color of the eyes in the living male points very strongly in this direction as does the similarity of genitalia. The paler abdominal and thoracic coloration is probably merely due to the type specimen being rather teneral. Futher collections and nymphal associations are needed from the Tilsonburg region to settle the matter.

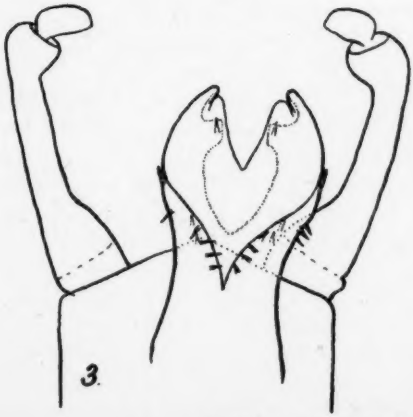


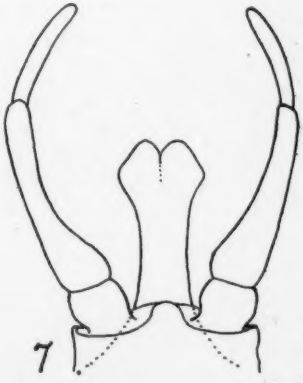












EASTERN EPHEMERELLA SPECIES

Ephemerella dorothea Needh.

Pl. XIII, fig. 5.

Ephemerella dorothea Needham, 1908, 23rd Rep. St. Ent. N. Y., 190; McDunnough, 1925, Trans. Roy. Soc. Can. (3), XIX, Sec. 5, 212, Pl. X, figs. 3, 4.

My note regarding this species and *cornuta* in the "Canadian Entomologist," 1928, p. 238 should be disregarded; it was based on a misassociation of nymph and adult. Our direct breeding experiments at Knowlton, where the nymphs were very abundant in the small mountain brooks, showed conclusively that my original reference of the Covey Hill specimens to *dorothea* was correct. The falsely associated nymphs occur in the same brooks as *dorothea* and prove to be those of the recently described *cornutella* McD.

The living males have bright red eyes which with their pale yellowish bodies renders them very beautiful objects; in the females the vertex of the head is rather bright red in well-colored specimens and the dorsal portion of the abdomen suffused with ruddy. The wings of the subimago are very pale smoky. Needham's figure of the male genitalia gives a good general idea of this organ but the position of the spines on the penes is not distinct; as in *invaria* there are lateral and dorsal groups and in addition scattered ventral spines in the same apical area as in *fratercula*.

The small brown, pale-speckled nymph with smooth head and no abdominal, dorsal spines has been well described in Needham's paper; in general characters it fits in excellently with the other known nymphs belonging to this section. It might easily be confused with the darker colored nymphs of *invaria* but apart from its rather slimmer shape and smaller size it is less hairy, showing scarcely any of the long hairs which clothe the dorsal edge of the femora in *invaria*, their place being taken by a single row of spicules; the postero-lateral spines are short, and the entire lack of dorsal abdominal spining is also useful as a means of separation as *invaria* nymphs usually show at least a trace of such spines.

MATERIAL EXAMINED. *Adults*:- Series of both sexes from Covey Hill, Que., Knowlton region, Que.; 2 ♂, Boiestown, N. B.; 3 ♂, 1 ♀, Gorham, N. H.; 1 ♂, 4 ♀, Blount Co., Tenn.; 1 ♂, Black Mts., N. C. *Nymphs*:- Long series from the Knowlton region.

Ephemerella subvaria McD.

Pl. XI, fig. 2.

Ephemerella invaria (dark form), McDunnough, 1925, Trans. Roy. Soc. Can., Ser. 3, XIX, Sec. 5, 213; Ide, 1930, Can. Ent., LXII, 211.
Ephemerella subvaria McDunnough, 1931, Can. Ent., LXIII, 84.

As noted in the original description this species is best separated from *rotunda* and *invaria* by the generally darker and duller coloration of the body and by the decidedly dark veins and crossveins on the wings. The male genitalia appear to offer no very good characters for separation although it might be noted that the two small apical ventral spines are generally lacking. The wings of the subimago are much deeper in color than the rather pale smoky ones of both *invaria* and *rotunda*. The nymph was first associated in 1930 from material collected in the St. Lawrence river at Cascades Point, Que. by Messrs. Walley and Milne. It is scarcely as large as that of *rotunda* and the dorsal abdominal spines are much better developed than in this species and not so flattened; the lateral prolongations are much as in *rotunda*. The coloration is frequently paler,

the dorsum of abdominal segments VI and VII being at times almost entirely pale and V with only a median subtriangular patch, contrasting strongly with the dark segments VIII and IX; the double dorsal row of pale spots is not present in the specimens examined. From the St. Lawrence form of *invaria*, mentioned later, which occurs in the same locality, it is readily separated by the presence of the dorsal spines. It also emerges a week or two earlier, being one of the first species to appear around Ottawa in the spring.

MATERIAL EXAMINED. *Adults*:- Long series of both sexes (including type material), from Cascades Pt., Lachine, Coteau du Lac, Que.; Prescott, Ottawa, Horning's Mills, Ont. *Nymphs*:- Series from Cascades Pt., Que.; Horning's Mills, Ont., including nymphal skins of bred specimens.

Ephemerella rotunda Morg.

Pl. XI, fig. 1, 3; Pl. XIII, fig. 1.

Ephemerella sp. Needham, 1905, Bull. 86, N. Y. Sta. Mus., 45, Pl. X, fig. 7.
Ephemerella rotunda Morgan, 1911, Ann. Ent. Soc. Am., IV, 113; McDunnough, 1926, Can. Ent., LVIII, 188.
Ephemerella vernalis Banks, 1914, Proc. Acad. Nat. Sci. Phil. LXVI, 614; McDunnough, 1925, Trans. Roy. Soc. Can. (3), XIX, Sec. 5, 213.
Ephemerella feminina Needham, 1924, Psyche, XXXI, 309.

The name was based originally on a female imago and several nymphs from the vicinity of Ithaca, N. Y. Later Needham, under the name *feminina*, called attention to the interesting fact that in that section of the state the species apparently only occurred in the female sex and reproduced parthenogenetically.

In 1930 in the late afternoon of June 4 Messrs. Walley and Milne found subimagos of both sexes emerging freely from a brook about 3 miles south of Knowlton, Que. and a series was secured which later produced adults; full grown nymphs were taken at the same spot and several of these bred through to adults to verify the tentative association. On returning to Ottawa it was found that the nymphs corresponded exactly with material of *rotunda*, kindly presented by Dr. Needham.

A careful study of slides of the male genitalia showed their absolute similarity to those of *vernalis* Banks, based on a male paratype in the Canadian National Collection; I have already noted the resemblance in genitalia between this species and *invaria* Wlk. but with more material at my disposal believe that the two may be satisfactorily distinguished by means of the spining of the apical section of the penes. *Invaria* (see my figure *op. cit.*, 1925, Pl. I, fig. 6) shows several lateral spines, dorsal spines at the apex of the V, and a single ventral apical spine; in *rotunda* (*vernalis*), besides these there are two small clusters of ventral spines (1-4) immediately beneath the dorsal ones which I have not found in any of the many slides of *invaria* before me. *Fratercula* McD. also shows ventral spines but these are situated more apically than those of *rotunda* and in addition the dorsal spines are lacking.

Apart from the larger size it is difficult to point out any satisfactory characters whereby the females of *rotunda* and *invaria* may be separated, the greater width of the head and the longer hind femur in *rotunda* are often useful but must be used with caution; direct breeding or more or less definite association with the male sex remains for the present the best means for correct determination. In the Knowlton region the species appears a week or ten days earlier than *invaria*, as far as our records go, and this is the only

Canadian locality in which *rotunda* is definitely known to occur although some unbred female specimens from Covey Hill, Que. and the Gatineau region look suspiciously like the species. Females, apparently parthenogenetic, have been taken in numbers along the Rideau river at Ottawa; these I place provisionally with *rotunda* as female nymphs, unbred as yet, from the same stream certainly are very close to our Knowlton nymphs although considerably lighter in color and with dorsal spines slightly less evident.

The nymph has already been described and certain of its details figured by Needham and Morgan; as compared with *invaria* it is larger, the double row of flat dorsal spines is better developed, each spine, although small, being distinctly evident and based on a small, round, pale spot situated on the posterior margin of segment; the postero-lateral edges of the segment are slightly more drawn out; the convexity of the outer margin of the pronotum is greater; the color of both thorax and abdomen is dark, sprinkled with fine pale dots, with little tendency to form any pattern except the above-noted double row of pale dots which, however, is not specific, being found generally in the nymphs of this section.

MATERIAL EXAMINED. *Adults*:- ♂ Paratype, *vernalis* Bnks.; ♀ series, McLean, N. Y. May 3, ♀ series, Rideau riv. Ottawa, Ont., (June); 8 ♂, 32 ♀, Knowlton, Que., June 20, 1927, June 12-14, 1928, June 4-13, 1930. *Nymphs*:- series from McLean, N. Y.; Rideau riv. Ottawa, Ont.; Knowlton, June 4, 1930, including nymphal skins of bred specimens.

Ephemerella invaria Wlk.

Pl. XIII, fig. 3.

Baetis invaria Walker, 1853, List Neurop. Ins. Brit. Mus., III, 568.
Ephemerella invaria Eaton, 1884, Rev. Mon. Rec. Ephem., 129; McDunnough, 1925, Trans. Roy. Soc. Can. (3), XIX, Sec. 5, 212, Pl. I, fig. 6; Ide, 1930, Can. Ent. LXII, 211.

This species, very similar to *rotunda*, appears to have a more northerly distribution. It occurs commonly in both sexes around all the smaller streams of the Gatineau region in early June and will probably be found throughout northern Ontario as the type specimens came from the Albany river; in the Ottawa river it is replaced by *subvaria* McD. and in the Rideau river by the form mentioned under *rotunda*; in the St. Lawrence region, however, a female form occurs along with *subvaria* which I assign here for the present, although the nymphs are rather larger and paler than typical; apparently the same tendency towards parthenogenesis crops up occasionally in this species as was found in *rotunda*. In southern Quebec it occurs at Covey Hill, Fulford, and throughout the Knowlton region, and most probably extends into the Adirondacks.

The nymph is smaller than that of *rotunda* and, as already noted, has less pronounced dorsal abdominal spining, these spines in many cases being practically obsolete. The color is apparently variable; nymphs from the Lapeche river, Wakefield, Que. and from Fulford, Yamaska river, Que. are pale ochreous, heavily sprinkled with brown dots; this sprinkling may be evenly distributed, or it may form crossbands of dark color across the anterior portion of the pronotum and between the bases of the wing pads on the mesonotum; the abdominal rows of pale dots found in *rotunda* are frequently present and in addition segments V and VI often show large lateral pale patches, the tendency being towards a coalescing of the pale areas to form an almost en-

tirely pale dorsum. Twenty miles north of Wakefield, in the Kazubazua river, the nymphs are considerably darker with heavier and more evenly distributed dark sprinkling whilst in the entire region south of Knowlton they are very dark, resembling in this respect small *rotunda*, brown being the predominant color with the ochreous reduced to mere sprinkling. Finally female nymphs from the St. Lawrence river (Cascades Pt.) besides being rather larger, are entirely without dorsal spines; they are as pale as our palest Wakefield ones and segments V and VI show only slight median brown sprinkling; they resemble considerably our Rideau river *rotunda* but the postero-lateral edges of the segments are scarcely produced enough for them to be placed here. More extensive breeding will be necessary to decide the status of these forms but so far I have been able to detect no sufficient differences in the adults to warrant specific separation.

MATERIAL EXAMINED. *Adults*:- Series of both sexes from Burk's Falls, Ont.; Kearney, Ont.; Wakefield, Que.; Kazubazua, Que.; Covey Hill, Que.; Fulford, Que.; and the Knowlton region, Que.; females from St. Lawrence region (Lachine, Vaudreuil). *Nymphs*:- Series from Wakefield, Kazubazua, Fulford, Knowlton and the St. Lawrence region, all early June; nymphal skins of bred specimens from Wakefield and Knowlton.

Ephemerella fratercula McD.

Ephemerella fratercula McDunnough, 1925, Trans. Roy. Soc. Can. (3), XIX, Sec. V, 213, Pl. I, fig. 5.

I have nothing to add to the original description where the points of distinction from *invaria* were noted and illustrated. The nymph is still unknown and the type locality, Covey Hill, Que., is the only one at which the species so far is known to occur.

Ephemerella aurivillii Bngtssn.

Pl. XIII, fig. 2.

Chitonophora aurivillii Bengtsson, 1908, K. Sven, Vet. Akad. Arsbok, VI, 243; *id.* 1909, Lunds Univ. Arssk. N. F. Afd. 2, V (4), 8; *id.* 1930, *op. cit.* XXVI, (3), 3.
Ephemerella aronii Eaton, 1908, in Esb. Pelt., Tromso Mus. Aarsh. XXV, 149; Walley, 1930, Can. Ent. LXII, 17, Pl. II, fig. 6; McDunnough, 1930, Can. Ent. LXII, 55; Ide, 1930, Can. Ent. LXII, 211.
Ephemerella norda McDunnough, 1924, Can. Ent. LVI, 223, Pl. V, fig. 5.
Chitonophora aurivilliusi Lestage, 1930, Bull. & Ann. Soc. Ent. Belg., LXX, 204.

This species has already been very fully discussed in the above-mentioned literature and I have nothing further to add on the subject.

(to be continued)

INVALUABLE WORDS

BY STANLEY F. BAILEY,
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Certain invaluable words and phrases as "apparently", "seems to be", and "it appears" have become to be an almost necessary part of the equipment of scientific invesigators and writers. The majority of the articles that come to hand are liberally sprinkled with such words, and perhaps not unnecessarily so. To one unfamiliar with the subject matter of an article or to a tyro in the field, the thought comes that the author is treading as if on thin ice and is hesitant to commit himself by drawing definite conclusions. Doubtless this is true and it is well that it is so for such an attitude makes for open mindedness and tolerance. It is ever a dangerous thing to approach the region where

opinions crystallize, and such words are buffers of the greatest import. Such "loop-hole" phrases offer a way out to investigators and probably often advert disagreements which many times result in bitter feelings. The words "apparently" and "probably" must serve on numerous occasions as life preservers in the rough experimental waters of science. The importance of the frequent and timely use of such words as "possibly" and "nearly" should be early impressed upon young scientists and authors. John Ray said that "Nature refuses to be forced into the fetters of a precise system" and, with the infinite number of exceptions and yet unexplained variances, a high premium should be placed upon such pertinent tools and indispensable servants to progress in scientific research.

BOOK NOTICE

Insects, Ticks, Mites and Venomous Animals of Medical and Veterinary Importance: Part I, Medical, by W. S. Patton and A. M. Evans, Crown 8 vo., 786 pages, 374 text figures, 60 plates, (5 dollars in Canada & U. S. A. postpaid); Part II Public Health, Crown 8 vo., 740 pages, 388 text figures, 57 plates, (6 dollars in Canada & U. S. A. postpaid).

These two volumes, designed respectively to meet the needs of the Medical profession and Medical Entomologists, and Public Health Workers, necessarily contain a duplication of some figures and text matter, but owing to the different angles of presentation each contains much that the other lacks and stresses a different phase of the subject. Both contain much valuable information on the anatomy, taxonomy, lifecycle, relation to man and disease, and control, of a great number of forms. These volumes should be very useful to those engaged in the various fields of Entomology and to Public Health workers.

R. H. O.

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